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ABSTRACT

This manual on methods of repairing damaged components and parts made of fiberglass/plastics is one of a series of texts and visual aids on operation, diagnosis, and repair of engine powered vehicles. Materials provide basic information with illustrations for use by vocational students and teachers as well as shop servicemen and laymen. Focusing on the nature of fiberglass/plastic, the first of four parts includes a discussion of what fiberglass/plastic is, materials for making it, how fiberglass/plastic parts are made, and types of damage. Part 2 describes materials and tools required for repairing fiberglass/plastic. The third part discusses repairing cosmetic damage such as scratches and gouges. Focusing on repairing structural damage, part 4 addresses the following topics: backing patches; hairline cracks; small fractures; simple curve; large fractures; simple curve; fractures; inaccessible underside; and fractures on a compound curve. Parts 3 and 4 conclude with test questions. Answers to the test questions are appended. (A supplementary 35mm slide set is also available--see availability note.) (LRA)

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FOS

Fundamentals of Service

Fiber Glass/Plastics

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TO THE READER

PURPOSE OF THIS MANUAL

The main purpose of this manual is to describe and demonstrate the approved methods of repairing damaged components and parts made of fiber glass/plastics. You are introduced to new terms, materials, safety precautions and repair tips with which you may not be familiar. The methods of applying the rather specialized materials required to repair damaged fiber glass/plastics, and the tools needed to apply them, are described in detail.

The manual can be used to advantage by experienced servicemen, shop trainees, vocational students and interested laymen.

The manual is written in a simple form so that it will be easily understood. The repair instructions are given in short, easy-to-follow steps with many illustrations to demonstrate each step.

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We, at John Deere, have prepared a series of these manuals called "Fundamentals of Service," or "FOS." These basic texts cover various subjects in the power mechanics field and can be applied to engine-powered vehicles of most any kind. Emphasis is on theory of operation, diagnosis of failures, and repair and adjustment of components.

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ACKNOWLEDGMENT

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THE NATURE OF FIBER GLASS/PLASTIC/PART 1

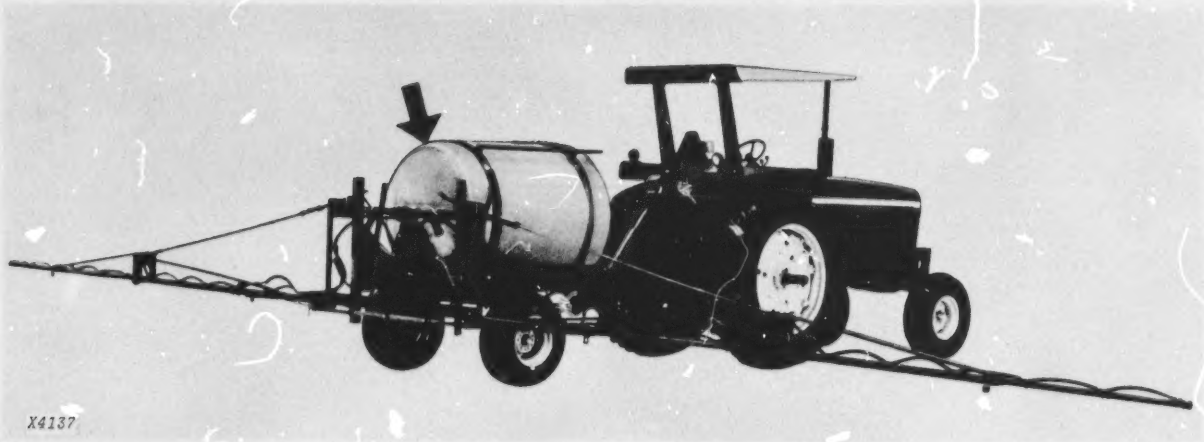

Fig. 1 — The Tank on This Agricultural Sprayer is Made of Fiber Glass/Plastic Because of Its High Resistance to Corrosive Chemicals

INTRODUCTION

Fiber glass/plastic (more properly termed fiber glass-reinforced plastic and often referred to as "FRP" or simply "Fiber Glass"), is a man-made composite material that is being used to manufacture literally thousands of useful products that have entered all phases of our modern living. Companies that make machinery for the farm, the garden, recreation, and off-the-road (construction) equipment are high among the industries that are taking advantage of this versatile material.

Figs. 1, 2, 3 and 4 show typical examples of equipment that have parts made of fiber glass/plastic because of its many desirable characteristics.

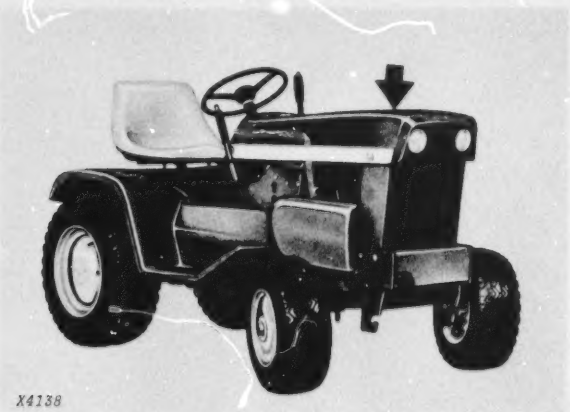

Fig. 2 — This Lawn and Garden Tractor Has a Fiber Glass/Plastic Hood

Fig. 3 — Strength and Light Weight Make Fiber Glass/Plastic an Ideal Material for the Hood and Console on This Modern Snowmobile

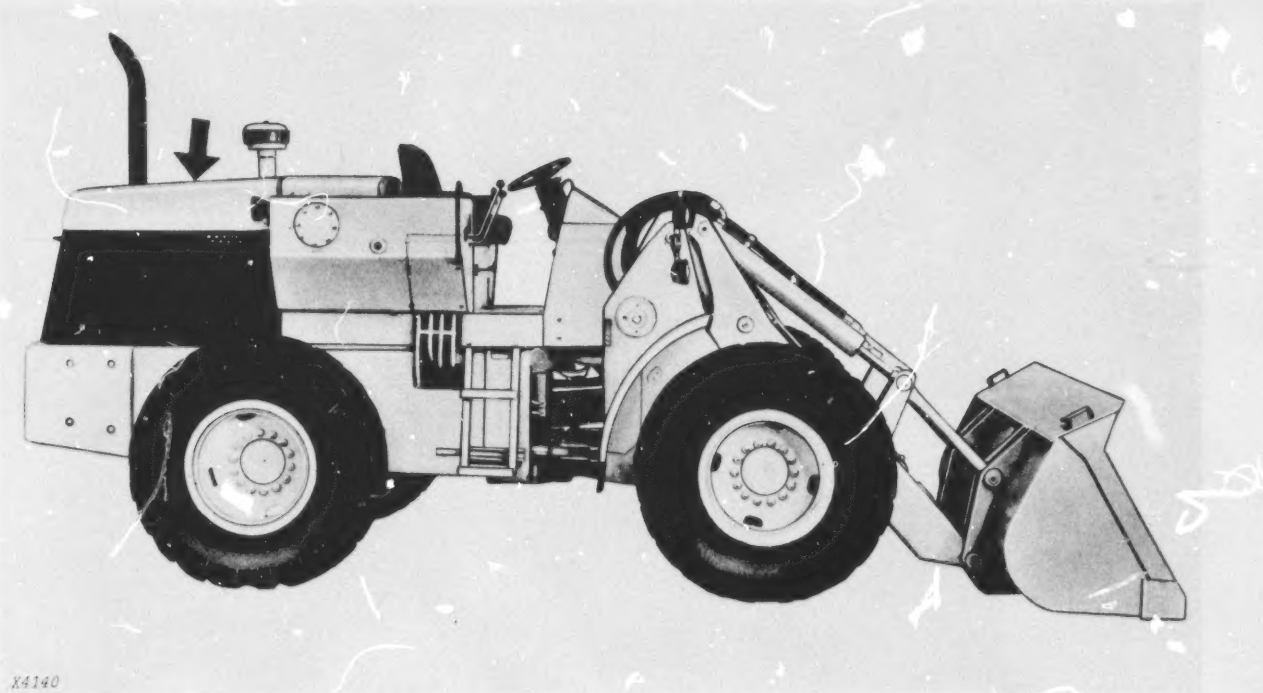

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Fig. 4 — The Fiber Glass/Plastic Engine Hood on This Industrial Loader Has Superior Impact Resistance and a Long-Lasting Finish

WHAT IS FIBER GLASS/PLASTIC?

Fiber glass/plastic is the term used to describe the combination of flexible strands of fibrous glass and a plastic. Usually the plastic is a *"thermosetting"* type; that is, one that hardens when heated but will not soften or melt when heated again. When the plastic and fiber glass strands are molded together the result is a material which has many desirable qualities.

Among these are:

- *Strength*
- *Light weight*
- *Good impact resistance*
- *Toughness*
- *Excellent weathering qualities*
- *Chemical inertness; water resistance*
- *Easily colored*
- *Good electrical insulating qualities*
- *Easily molded into intricate shapes*

These properties and characteristics have made fiber glass/plastic an important material from which thousands of items are made. No other single basic material, such as metal or wood, has all of the desirable qualities of fiber glass/plastic composite.

MATERIALS FOR MAKING FIBER GLASS/PLASTIC

Since fiber glass/plastic is a combination of *fibrous glass* and *plastic resin,* let's look briefly at these two major materials.

The Glass

There are several different forms of glass fibers available, depending on the molding method and the product to be made. The fibers are formed from molten glass which are then converted into forms usable for plastic reinforcement.

Molten glass flows through tiny holes at the base of an electric furnace and is drawn by mechanical means onto a gathering device at a high rate of speed (often approaching 2 miles per minute).

After treatment with a material called a "size" to make easier handling and to assure good adhesion between the plastic and the glass, the strands of glass are twisted, wound, woven or cut to fabricate the end product.

The Plastics

Plastics are synthetic or man-made materials. They are formed through chemistry by taking apart ingredients such as coal, water, air, petroleum, limestone, salt, etc., and putting them together in different, desirable combination.

Many plastics, commonly referred to as *resins,* are available for the production of fiber glass/plastic. The most important is a family of thermosetting resins known as polyesters. These are made by combining organic materials under special conditions to form very complex organic compounds known as *esters;* hence the name *"polyesters."*

These resins weather well and are quite resistant to most chemicals. They are strong, tough, withstand heat (up to 500° F.) and are good electrical insulators. Coloring is easily done simply by adding pigments or dyes. Other resins have become important in the production of fiber glass/plastic, mainly for special characteristics they impart. Among these are epoxy, phenolic, melamine and silicone resins. But polyesters continue to be the most important.

HOW FIBER GLASS/PLASTIC PARTS ARE MADE

To make a part from fiber glass/plastic, the glass reinforcement and the resin are combined in a mold and the resin is "cured" by heating. There are many methods of doing this from use of simple hand molds to intricate pressure or vacuum types. The desired end product determines to a large extent the method of producing the part.

* * * * *

The remaining information in this manual explains what kind of damage to fiber glass/plastic can be repaired, lists the materials required, and describes and illustrates in detail the procedures for making the repairs.

These include instructions for repairing simple scratches and gouges, and more extensive types of damage that affect the strength as well as the appearance of the damaged part.

Techniques for making backing patches and repairs to surfaces with simple and more complicated curves are described and illustrated.

TYPES OF DAMAGE

Damage to fiber glass/plastic falls into two main categories:

1. **Cosmetic damage**
2. **Structural damage**

Cosmetic damage means cracking and surface scratches and gouges that affect the appearance of the part.

Structural damage, on the other hand, is any type of damage that penetrates through the molded fiber glass and plastic composite called the "laminate." Such damage affects the structural soundness of the damaged part. Structural damage may range from hairline cracks to large fractures or punctures.

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Scratches and Gouges (Fig. 5)

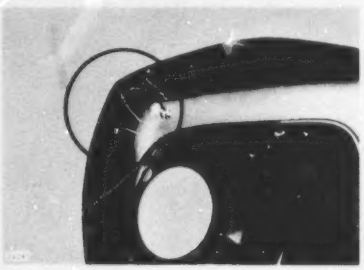

Fig. 5 — A Typical Scratch

The first type of damage is a minor one. It consists of scratches or gouges that penetrate through the surface and only slightly into the laminate.

Hairline Cracks (Fig. 6)

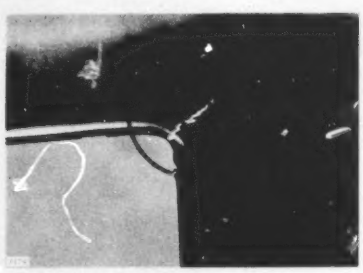

Fig. 6 — Hairline Crack

A hairline crack is more severe. It is an obvious separation extending completely through the laminate. Cracks can occur in the center of the damaged part, or can extend from an edge as illustrated.

Small Fractures — Simple Curve (Fig. 7)

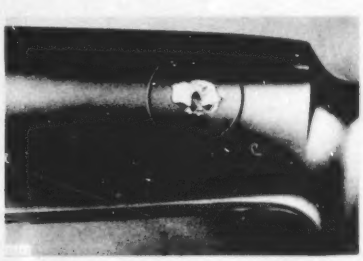

Fig. 7 — Small Fracture on a Simple Curve

Small fractures are holes or punctures less than 3 inches in size that occur on a flat surface or one with a simple curve.

Large Fracture — Simple Curve (Fig. 8)

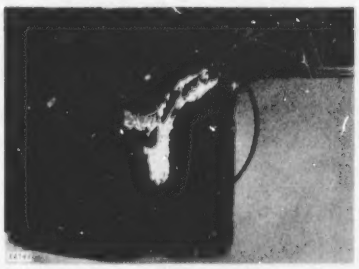

Fig. 8 — Large Fracture

Large fractures are holes or punctures 3 inches or more in length that occur on a flat surface or one with a simple curve.

Fractures Where Underside is Inaccessible (Fig. 9)

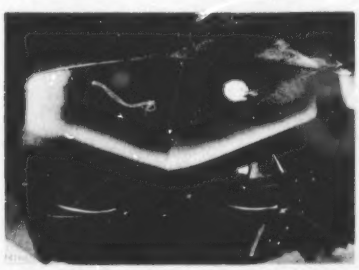

Fig. 9 — Fracture in an Area with Inaccessible Underside

All structural damage requires the use of a backing patch on the underside of the damaged area. Fractures on surface areas with limited or no access to the underside require special techniques.

Fractures on Compound Curve (Fig. 10)

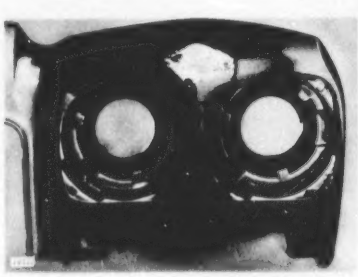

Fig. 10 — Fracture on a Compound Curve

Fractures on surfaces having curvature in more than one direction also require special techniques.

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MATERIALS AND TOOLS REQUIRED FOR REPAIR/PART 2

MATERIALS REQUIRED

Repair Kits

Many of the basic materials required to make repairs can be obtained in kits available from several manufacturers. These are usually adequate for small repairs or occasional use. When more extensive or intricate work is to be done, other materials, often not found in the kits, will be needed. In all cases be sure to follow the instructions and heed the precautions on the containers.

Typical materials required to make adequate repairs are described and illustrated below.

Fiber Glass Mat (Fig. 11)

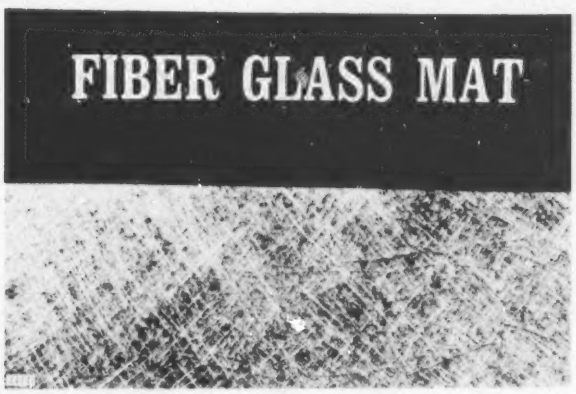

Fig. 11 — Fiber Glass Mat

Fiber glass mat is a blanket of randomly arranged glass fibers. Because of its thickness, mat is used when a rapid build-up of material is desired to speed the job. Also, mat is very pliable when saturated with resin which makes it ideal for repairing compound curves.

Mat is identified by its weight in *ounces per square foot*. For most repairs, 1½-ounce mat is recommended.

The table in the next column tells in detail what weight of mat to use, depending on the thickness of the part to be repaired.

WEIGHTS OF MAT

Thickness of Laminate (Part)	Layers of Mat	Weight of Mat
0.100″	3	1½ oz.
0.110″	3	1½ oz.
0.120″	2 and 1	1½ oz. and 2 oz.
0.130″	1 and 2	1½ oz. and 2 oz.
0.140″	3	2 oz.
0.170″	2 and 2	1½ oz. and 2 oz.

Fiber Glass Cloth (Fig. 12)

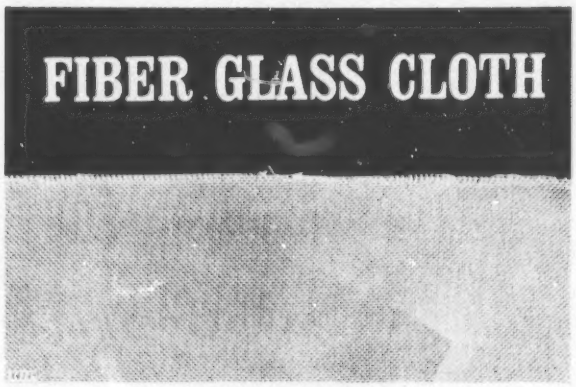

Fig. 12 — Fiber Glass Cloth

Fiber glass cloth is used where the most strength and the least thickness is required. It can be used as the first layer of backing patches but is not actually necessary.

Glass cloth is made from continuous glass fibers (much like thread) and is woven on regular textile machinery. It is identified by its weight in *ounces per square yard*. Where required, a 10-ounce cloth is recommended.

Resin (Fig. 13)

Fig. 13 — Polyester Resin and Hardener

Resin is a liquid plastic that hardens when combined with another substance known as a catalyst.* Polyester resin is most commonly used because it is inexpensive and hardens (cures) quickly, a desirable characteristic for constructing backing patches.

Resin Additives

Sometimes results may be improved by the addition of materials that will change the viscosity or "body" of the resin. The following may be used with polyester resin.

Fillers. Adding fillers such as shreds of fiber glass mat will provide both body and reinforcing strength.

Fig. 14 — Cab-o-Sil Thickener

Thickeners (Fig. 14). Thickeners such as Cab-O-Sil provide additional body to the resin. Increased body is often desirable to keep the resin from running when working on a vertical surface.

Epoxy Adhesive (Fig. 15)

Fig. 15 — Epoxy Adhesive and Hardener

Epoxy adhesive is used to cement a preformed patch to the back of the area being repaired. Epoxy creates a strong, durable bond when used properly.

Body Fillers (Fig. 16)

Fig. 16 — Body Filler, Hardener and Glazing Putty

Polyester body filler is used to re-establish the original surface of the repaired area. It is easy to apply and shape to the contour of the surrounding piece.

Sometimes, after shaping and finishing, the filler may have fine pinholes. These can be filled with glazing putty to provide a smooth surface for painting.

Always mix filler on a hard surface like Formica or Teflon. Do not mix on a porous surface such as cardboard.

**A catalyst is a substance which, when added to a mixture of other materials, speeds up chemical reaction. The catalyst itself does not enter into the chemical reaction; it remains unchanged.*

Suggestions for Preserving Materials

Fig. 17 — Dating Resin Can

Keeping Records. Put a date (Fig. 17) on each can of resin purchased. By so doing you can always use the oldest stock first. A word of caution here — the shelf life of resins varies; therefore they should be tested before use and discarded if any deterioration has taken place.

Fig. 18 — Materials Properly Stored

Storage. Always carefully seal all containers after use and store them in a closed cabinet located in a cool, dry area. (Fig. 18). This will reduce aging caused by changing temperatures.

TOOLS AND RELATED MATERIALS

No special tools are used in any of the repair procedures described in this manual. All the necessary tools can generally be found in most well equipped shops, or can be readily obtained at nominal cost. Tools and materials most often used are illustrated below and listed on the next page.

Fig. 19 — Typical Tools and Other Materials Required to Make Repairs

- Sandpaper and sanding disks (24- to 80-grit and 360- to 600-grit)
- Air motor or electric drill with sanding attachment and burr bit
- Sanding block
- Orbital or flat reciprocating sander
- Electric saber saw or hacksaw
- C-clamps, or equivalent holding devices
- Files including "cheese grate" plane
- Xylol or equivalent wax remover
- Fiber glass mat
- Polyester resin
- Epoxy adhesive*
- Body filler and squeegee
- Glazing putty
- Plastic separating film
- Masking material and masking tape
- Scissors
- Goggles and respirator

*There are a number of epoxy adhesives suitable for cementing patches to parts made of polyester resin. Among those that give satisfactory results when used according to the manufacturer's directions are the following:

Company	Name or Identification of Adhesive
Sherwin-Williams Paint Company	Kermak (R)
Minnesota Mining & Manufacturing Company	1751
Shell Chemical Company	Epon 828 w/ Versanid 125
REN Plastics, Inc.	RP-1258
Celanese Resin Company Division of Celanese Chemical Company	5109 w/Epi-Cure 861-M

WORK SAFELY

Performing fiber glass/plastic repairs is as safe as performing other repairs provided proper precautions are taken and good shop practices are followed. As in any other work, a safe worker understands and respects the tools, equipment and materials he works with.

IMPORTANT: Before using any materials, thoroughly read the manufacturer's instructions, especially the cautions and warnings.

Room Ventilation

Prolonged exposure to resin fumes can be irritating to the skin and eyes. Be sure the room is adequately ventilated. A large fan is ideal, provided that you also have a source of fresh air.

Grinding and Sanding

While grinding and sanding, protect your face and body from the fine dust that develops.

Fig. 20 — Using a Respirator and Goggles

Use a respirator mask (Fig. 20) to keep from inhaling dust if the grinding or sanding is extensive.

Wear goggles or safety glasses to protect your eyes.

⚠ CAUTION: Do not rub your face or eyes when working with fiber glass. Small slivers, when embedded, are difficult to remove and may cause infection.

If available, it's a good idea to wear a disposable paper shop coat to keep dust and fiber slivers out of your clothing.

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REPAIRING COSMETIC DAMAGE/PART 3

PREPARATORY STEPS

Perform the four steps given below before beginning any fiber glass/plastic repair.

1. Check shop temperature and humidity and compare with recommendations on resin can label. Normal room temperature and humidity are usually specified. (70° F. and 70 percent humidity are considered ideal.)

NOTE: Cool temperatures will prolong the time required for curing while high temperatures will reduce the time. If humidity is high, moisture may be absorbed by the resin which may inhibit curing and leave the surface tacky.

2. Gather required tools and materials.

3. Clean the damaged area, both outside and inside, with xylol or equivalent wax remover; then inspect the area closely, and

4. Push on the area around and underneath the damage to determine just how extensive it is.

SCRATCHES AND GOUGES

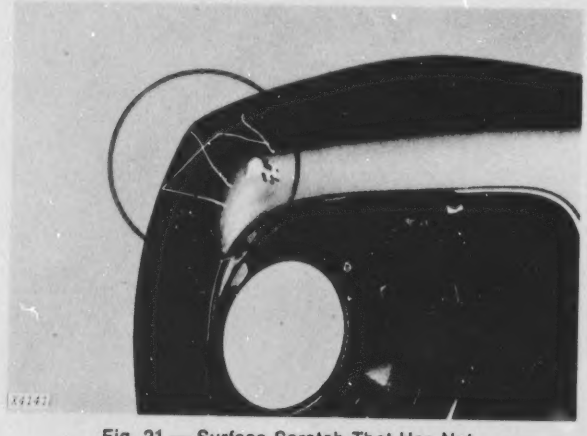

Fig. 21 — Surface Scratch That Has Not Penetrated the Laminate

DEFINITION

In general, a scratch or gouge (Fig. 21) is minor damage that penetrates through the surface and only slightly into the laminate.

TOOLS AND MATERIALS REQUIRED

- Sandpaper and sanding disks (24- to 80-grit and 360- to 600-grit)
- Air motor or electric drill with sanding attachment and burr bit
- Files including "cheese grate" plane
- Sanding block
- Orbital or flat reciprocating sander
- Xylol or equivalent wax remover
- Heat gun or heat lamp
- Body filler and squeegee
- Glazing putty
- Masking material and masking tape
- Scissors
- Goggles and respirator

PREPARATORY STEPS

Perform the four preparatory steps given in the left-hand column at the top of this page.

REPAIR PROCEDURES

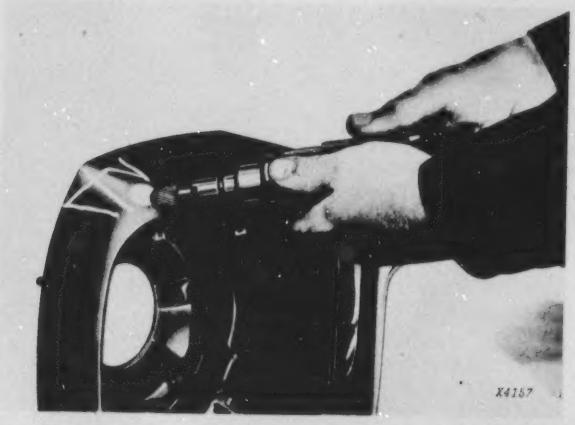

Fig. 22 — Forming a V-Groove for the Length of the Scratch

1. Using a burr bit on a power drill, rout a V-groove (Fig. 22) along the length of the scratch or gouge. Do not taper the sides of the V more than 45 degrees. Do not cut through the laminate.

CAUTION: Wear goggles and respirator when cutting, grinding or sanding.

Fig. 23 — Removing Flaky Edges with Sandpaper

2. Remove flaky edges (Fig. 23) and feather the surface back about ½ inch beyond the damaged area by hand-sanding or power-sanding with 360-grit sandpaper.

3. Clean the area with a dry cloth or compressed air.

IMPORTANT: Do not wipe with solvent.

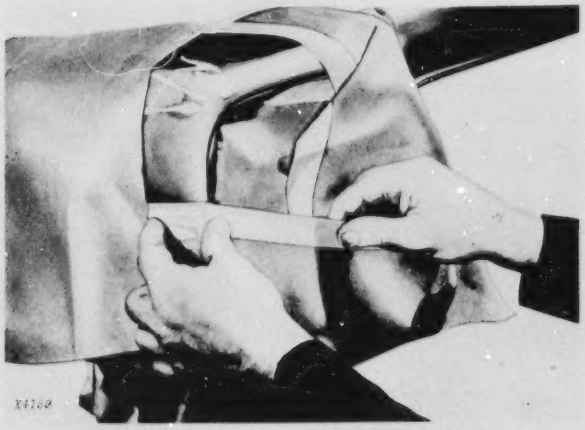

Fig. 24 — Masking Undamaged Surface

4. Mask off the undamaged surface (Fig. 24), leaving a working area of approximately 5 inches surrounding the repair area.

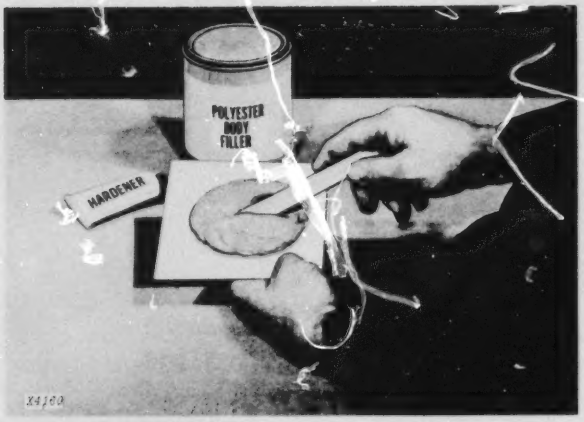

Fig. 25 — Mixing Body Filler and Hardener

5. Following the manufacturer's instructions, mix enough polyester body filler (Fig. 25) to reestablish the surface.

IMPORTANT: Mix filler on Formica, Teflon or other hard surface. Do not work on a porous surface such as cardboard.

Fig. 26 — Applying and Spreading Filler

6. Apply and spread filler with a plastic squeegee (Fig. 26), making sure to remove large air bubbles. Extend filler above original surface to allow for shrinkage.

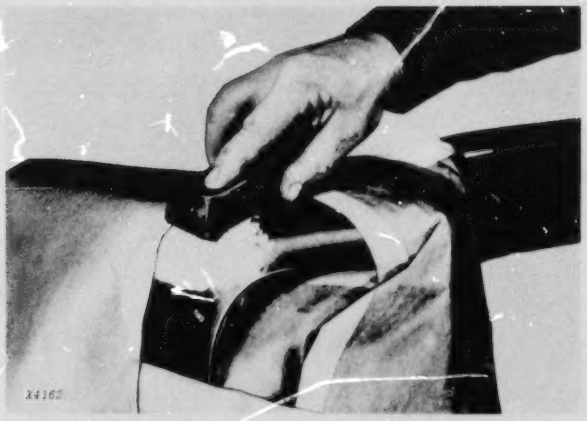

Fig. 27 — Filing Off Excess Filler

7. Let filler set up until it is rubbery but not fully hardened. Then reestablish original contour by planing or filing off excess (Fig. 27), still leaving the filler level slightly higher than that of the original surface.

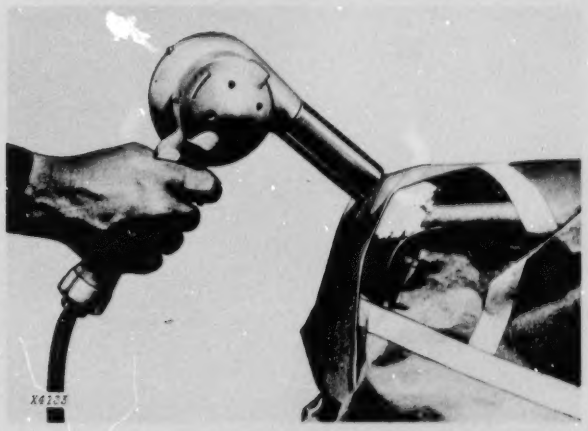

Fig. 28 — Using Heat Gun to Pre-shrink Filler

8. Shrink filler, using a heat gun or heat lamp (Fig. 28). A minimum temperature of 120° F. is required for shrinkage.

IMPORTANT: Keep heat source at least 12 inches away from repair area.

Fig. 29 — Sanding Repaired Area

9. Now power-sand the filler with 360-grit sandpaper (Fig. 29) until it is smooth and even with the original surface.

Fig. 30 — Applying Glazing Putty to Fill Pinholes

10. If the filler is slightly porous (has fine pinholes), apply a thin coat of glazing putty (Fig. 30) and cure it under the heat gun or lamp.

NOTE: If the filler is pockmarked, do not use glazing putty at this time. Instead, apply another layer of body filler, following steps 5 through 10.

Fig. 31 — Repaired Area Final Sanded

11. Finish by sanding (Fig. 31) with a sanding block and 360-grit sandpaper.

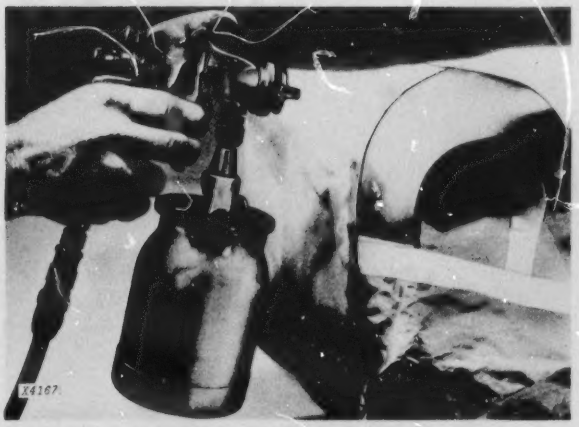

Fig. 32 — Painting Repaired Area

12. Complete the repair by cleaning the area with compressed air. Remask, if necessary, then spot prime, wet-sand lightly and paint (Fig. 32).

TEST YOURSELF

QUESTIONS

1. Name three characteristics of fiber glass/plastic that make it a useful material.
2. What is the family of plastics most used to make fiber glass/plastic parts?
3. What are the two common types of damage to fiber glass/plastic parts most often encountered?
4. True or False? Fiber glass mat is identified by its weight in ounces per square yard.
5. What is a catalyst?
6. What is a "thermosetting" plastic?
7. What is xylol used for?
8. True or False? Always use solvent to clean a repair area.
9. What grit sandpaper is best for final sanding?
10. True or False? Cardboard is an ideal material to use when mixing body filler and hardener.
11. Always wear what when cutting, sanding or grinding fiber glass/plastic parts?

ANSWERS

1. Strength, light weight, easily molded, among others.
2. Polyesters.
3. Cosmetic and structural.
4. False. It is identified in ounces per square *foot*.
5. A chemical that, when added to resin and epoxy, causes them to harden.
6. One that hardens when heated but will not soften or melt when heated again.
7. To remove wax, grease or other foreign material.
8. False. Never use solvent for cleaning.
9. 360-grit or finer.
10. False. Use Formica, Teflon or similar hard surface.
11. Goggles or safety glasses and a respirator.

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REPAIRING STRUCTURAL DAMAGE/PART 4

The procedures given next are used for repairing various types of damage to the laminate. These include:

- Hairline cracks
- Large and small fractures
- Punctures

These types of damage affect the structural soundness of the laminate itself.

BACKING PATCHES

All structural repairs call for the use of backing patches, or back-up strips. They are simply laminates that are formed in the shape of the surface to be repaired, and bonded with epoxy cement to the back side of the repair area.

A backing patch serves two functions:

1. It provides the foundation to build and form the exterior surface to match the original contour.

2. It provides the mechanical strength needed to keep a repair structurally and visually intact during normal operation or usage.

A repaired laminate must be as strong as the original material surrounding it. If it is not, the repair will not last and generally will crack around the edge of the patch.

To compensate for the difference in elasticity of the backing patch (hand lay-up) and that of the original laminate (usually compression molded), the backing patch must be thicker than the original. The chart on page 5 gives comparable thicknesses.

Many fiber glass/plastic parts are 0.100 inch thick; therefore, the minimum backing patch thickness must be 0.126 inch, or three layers of 1½-ounce mat.

PREPARING A BACKING PATCH

MATERIALS REQUIRED

- Fiberglas mat (usually 1½ oz. — for more information see chart on page 5).
- Polyvinal alcohol, cellophane or similar plastic separating film
- Masking material and tape
- Polyester resin

PROCEDURE

The following steps describe the procedure for forming a backing patch to the outside surface of the damaged part. If the inner surface is accessible, however, it is preferable to form the patch to this side. The steps are the same.

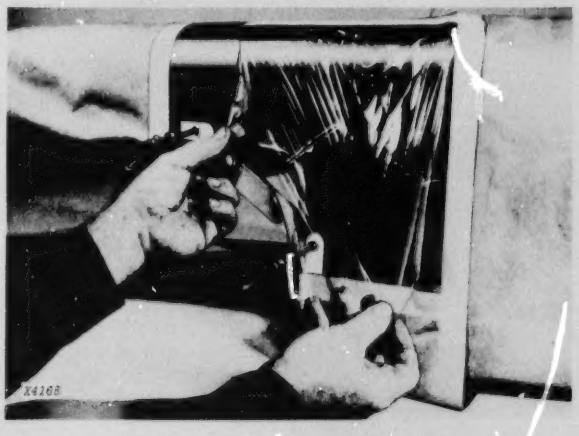

Fig. 33 — Covering Repair Area with Separating Film

1. Cut a piece of plastic separating film large enough to extend approximately 3 inches beyond the edge of the repair area (Fig. 33). Tape the film to the outside of the repair surface.

Fig. 34 — Cutting Fiber Glass Mat Using Cardboard Template as a Guide

2. Using a cardboard template, cut the required pieces of polyester mat (see table, page 5) large enough to extend 2 inches beyond the edges of the repair area (Fig. 34).

Fig. 35 — Mixing Polyester Resin and Hardener

3. Mix the recommended amount of polyester resin (Fig. 35) according to the instructions on the can.

4. Apply some resin to the working area of the separating film (Fig. 36). Then place the first layer of mat on the separating film.

5. Saturate the mat with resin, using a stippling motion; that is, tap the mat frequently with the ends of the bristles of the brush. Allow the mat to harden slightly.

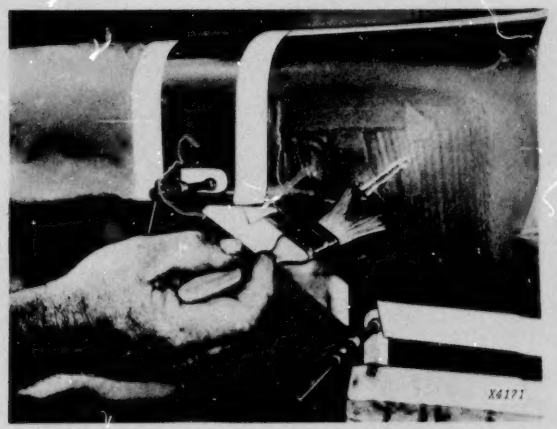

Fig. 36 — Applying Resin to Working Area of Separating Film

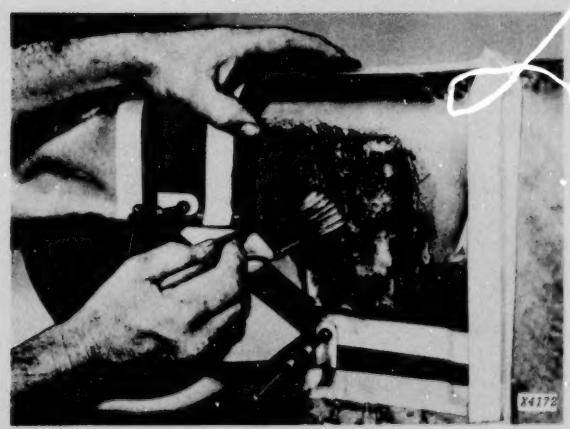

Fig. 37 — Applying Resin-Soaked Mat

6. Now lay up by hand the remaining piece or pieces of resin-soaked mat (Fig. 37).

NOTE: To prevent the mat from sliding on a vertical surface, tape a piece of plastic film over the patch.

7. Allow the patch to harden; then pop it off and remove the separating film.

NOTE: If you used polyvinyl alcohol as the separator, wash the patch and repair surface with water and allow them to dry thoroughly.

The backing patch is now available to repair the various types of damage described on the pages which follow.

HAIRLINE CRACKS

DEFINITION

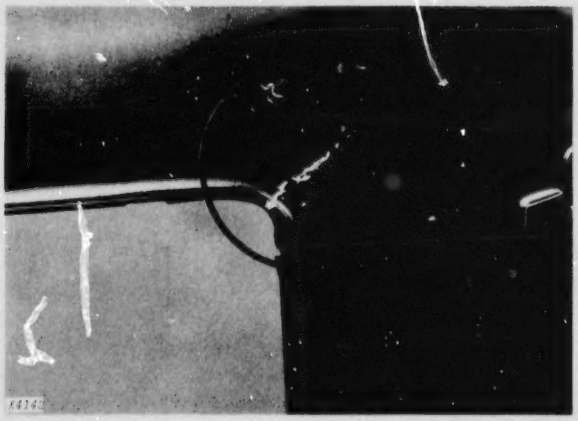

Fig. 38 — A Hairline Crack

A crack (Fig. 38) is an obvious hairline separation extending completely through the laminate. Cracks can occur in the center of the laminate or extend from the laminate edge due to stress beyond normal operation.

NOTE: The procedure for repairing a crack is the basic repair procedure for all types of structural damage. Therefore, only the modifications to this basic procedure are given for large and small fractures.

REPAIR PROCEDURES

1. Perform the preparatory step given on page 9.

2. Gather the required tools and materials (see pages 5 through 8).

3. Using a tapered bit or saber saw (Fig. 39), remove the cracked and flaked fiber glass until the crack is at least ⅛ inch wide.

CAUTION: Wear goggles and respirator when cutting, grinding or sanding.

Fig. 39 — Sawing Out Cracked and Flaked Fiber Glass

Fig. 40 — Aligning Panel by Use of C-Clamps

4. If panel is out of alignment, realign it with C-clamps (Fig. 40) or other clamping devices.

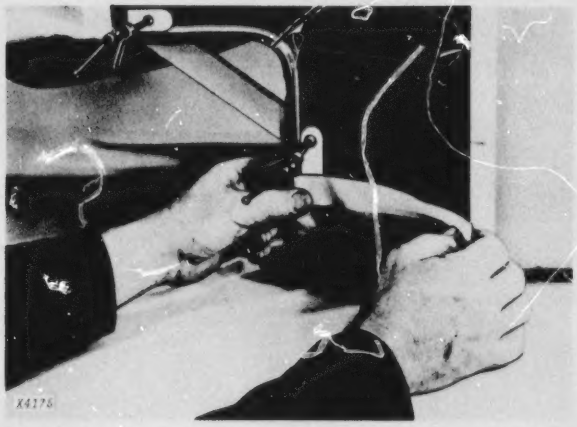

Fig. 41 — Masking Undamaged Surface

5. Mask off undamaged surface (Fig. 41), leaving a working area of approximately 5 inches surrounding the crack.

6. Prepare a backing patch according to the procedures given on pages 13 and 14.

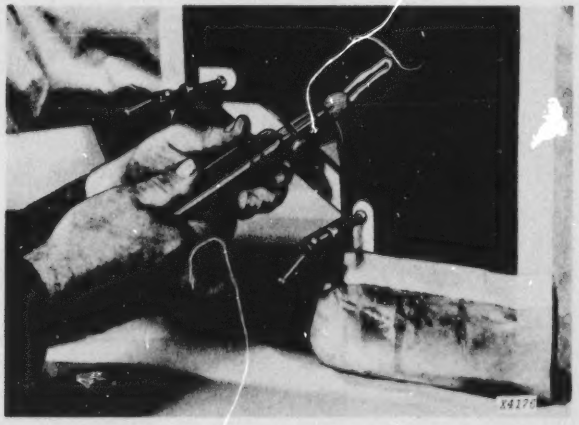

Fig. 42 — Tapering Edges of Crack

7. Working from the outside and using a file or grinder (Fig. 42) taper the edges of the crack at angle of no more than 45 degrees.

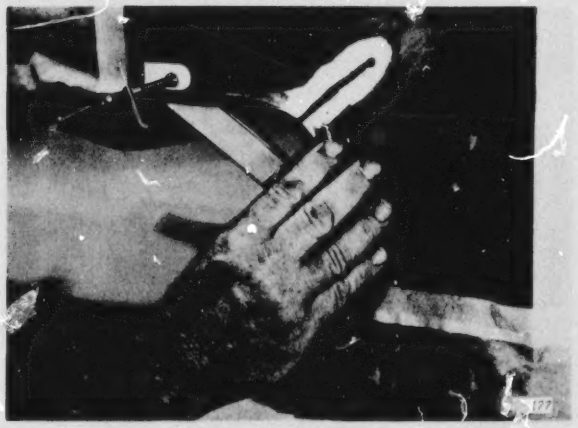

Fig. 43 — Removing Flaky Edges

8. Remove flaky edges and feather the surface back about ½ inch beyond the damaged area by hand-sanding or power-sanding (Fig. 43), with 360-grit sandpaper.

9. Clean the area with a dry cloth or air.

IMPORTANT: Do not wipe with solvent.

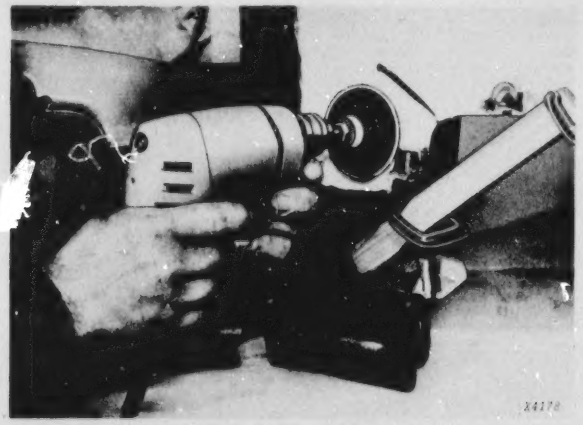

Fig. 44 — Sanding Underside of Repair Area

10. Sand the underside of the repair area with 80-grit (or less) sandpaper (Fig. 44) to create a rough bonding surface approximately 2 inches from the center of the crack.

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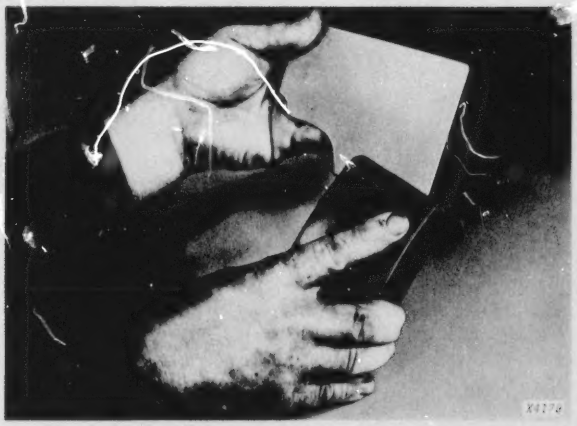

Fig. 45 — Roughening Backing Patch with Sandpaper

11. Trim the backing patch. Then sand the mating surface of the backing patch with 80-grit (or less) sandpaper (Fig. 45), checking for smooth fit to the underside. Clean all surfaces with air.

12. Hold the backing patch in position under the damaged area. Mark its position relative to the underside of the panel. Outline the outer edge of the damaged area on the patch. This will give you a reference point when applying the epoxy adhesive.

Fig. 46 — Backing Patch Held in Place by C-Clamps

13. Now determine the method of holding backing patch in place (C-clamps, self-tapping screws, etc.), and trial test (Fig. 46). If you use self-tapping screws, pre-drill the holes. Before finishing the surface, you will remove the screws and fill the holes with body filler as instructed later.

Fig. 47 — Mixing Epoxy Adhesive and Hardener

14. Mix epoxy adhesive (Fig. 47) according to instructions.

Fig. 48 — Applying Adhesive to Underside of Repair Area

15. Apply the adhesive to underside of repair area and patch (Fig. 48). Try not to get adhesive on the area under the groove. Press patch in place until epoxy squeezes out from all edges.

NOTE: If adhesive squeezes into the tapered groove during bonding, clean it out before the adhesive sets, and roughen the remaining adhesive with 360-grit sandpaper after it hardens.

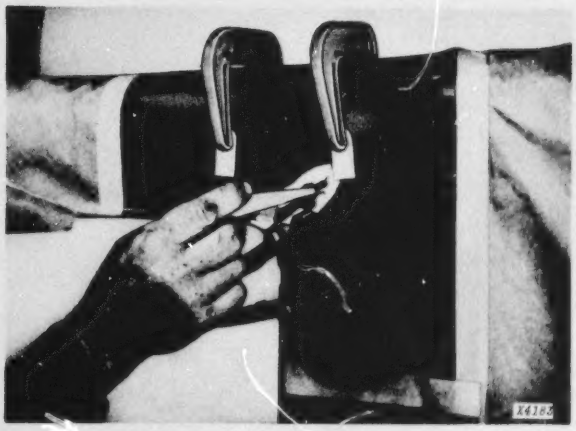

Fig. 49 — Backing Patch Clamped in Place

16. Hold the backing patch with clamps or screws (Fig. 49) and allow the adhesive to harden for the time given in the manufacturer's instructions.

17. Following the manufacturer's instructions, mix enough body filler to reestablish the surface.

IMPORTANT: Mix filler on Formica, Teflon or other hard surface. Do not work on a porous surface such as cardboard.

If you used screws to align the panel or hold the back patch in place, remove the screws at this time.

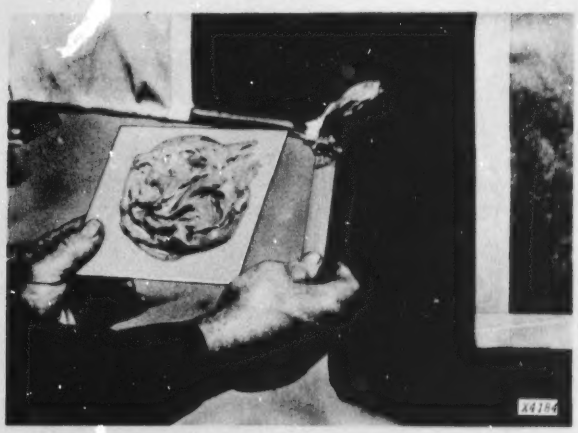

Fig. 50 — Body Filler Worked into Tapered Crack

18. Work the filler into the tapered crack with a squeegee (Fig. 50), making sure to fill all voids and to remove large air bubbles.

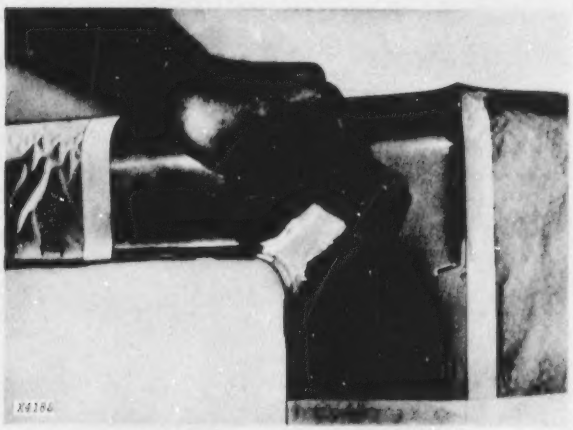

Fig. 51 — Filing Off Excess Body Filler

19. When the filler is firm to the touch, file or plane off the excess (Fig. 51), still leaving the filler level slightly above that of the original surface.

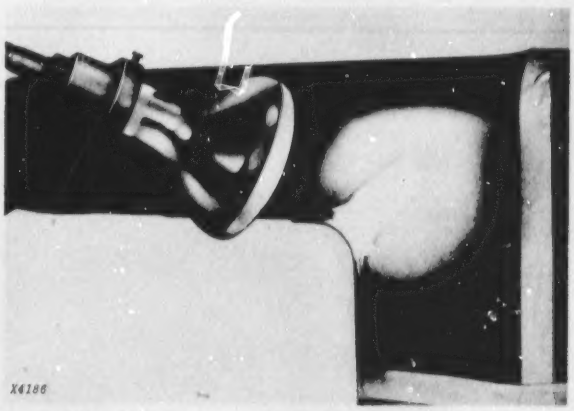

Fig. 52 — Pre-Shrinking Filler with Heat Lamp

20. Now, shrink the filler, using a heat gun or heat lamp (Fig. 52). A minimum temperature of 120° F. is required for shrinkage.

IMPORTANT: Keep heat source at least 12 inches away from repair area.

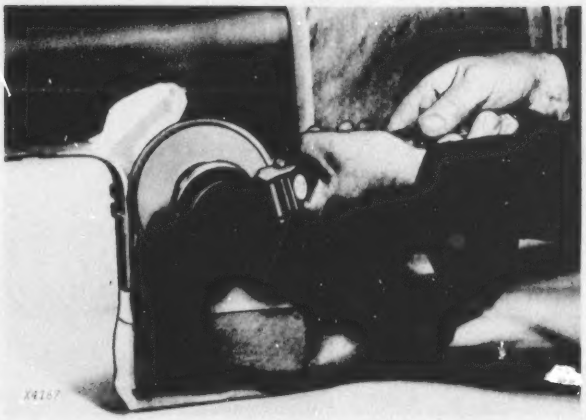

Fig. 53 — Sanding the Filler

21. Power-sand the filler (Fig. 53) with 360-grit sandpaper until it is smooth and even with the original surface.

22. If the filler is slightly porous (has fine pinholes), apply a thin coat of glazing putty (Fig. 54).

NOTE: If the filler is pockmarked, do not use glazing putty at this time. Instead, apply another layer of body filler, following steps 17 through 22 above.

23. Allow glazing putty to cure under heat gun or heat lamp. Finish by sanding with a sanding block and 360-grit sandpaper.

24. Complete the repair by cleaning the area with air. Remask, if necessary; then spot prime, wet-sand lightly and paint (Fig. 55).

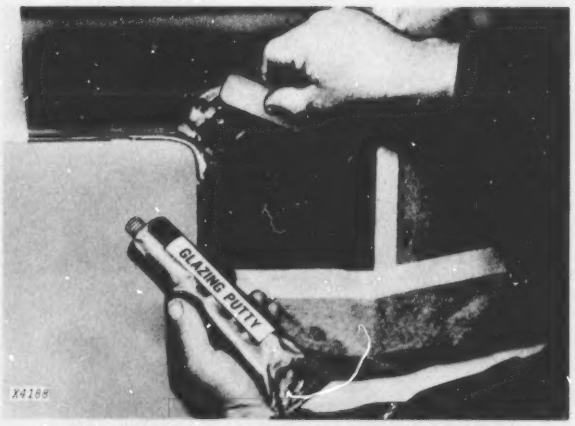

Fig. 54 — Filling Pinholes with Glazing Putty

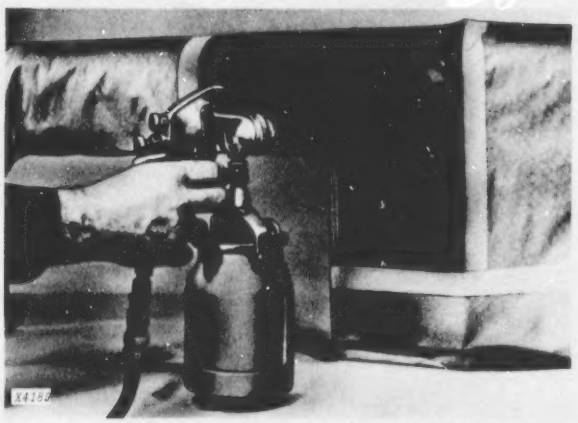

Fig. 55 — Painting Repaired Area

SMALL FRACTURES — SIMPLE CURVE

DEFINITION

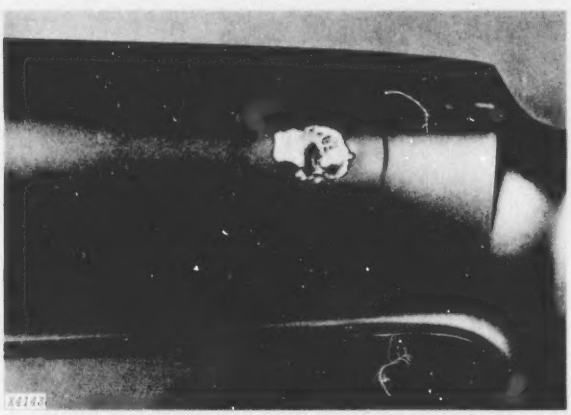

Fig. 56 — Typical Small Fracture or Puncture

Small fractures are punctures of 3 inches or less in size (Fig. 56).

REPAIR PROCEDURES

1. Gather the tools and materials listed on pages 5 through 8.

2. Repeat the preparatory steps given on page 9.

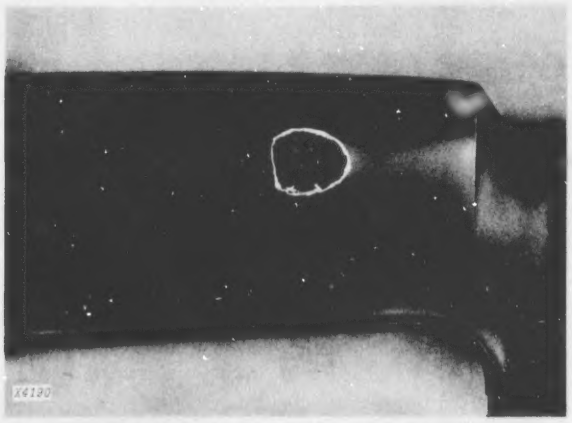

Fig. 57 — Cracked and Flaked Edges Cut Away

3. Cut away the cracked and flaked edges (Fig. 57), using a saber saw or other appropriate tool.

CAUTION: Wear goggles and respirator when cutting, grinding or sanding.

4. If the fracture is at the edge of the panel and if the panel is out of alignment, realign it with C-clamps or similar holding devices.

5. Clean the area with a dry cloth or compressed air.

IMPORTANT: Do not wipe with solvent.

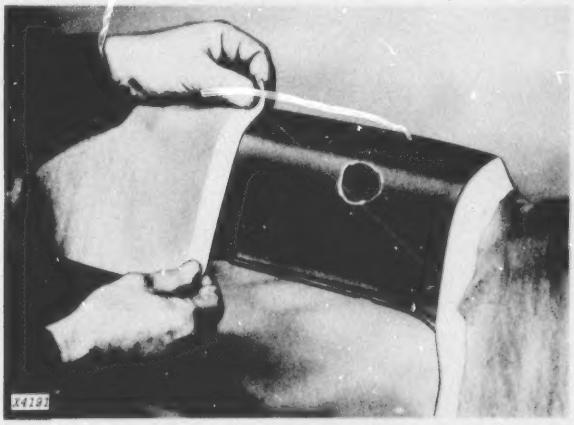

Fig. 58 — Masking Off Damaged Area

6. Mask off undamaged surface, leaving a working area of approximately 5 inches surrounding the fracture (Fig. 58).

7. Prepare a backing patch according to the procedures given on pages 13 and 14.

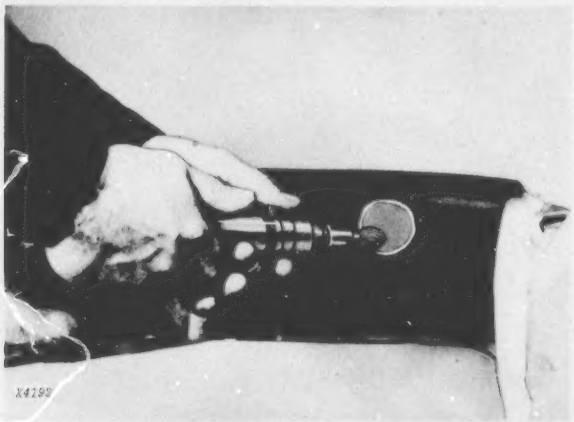

Fig. 59 — Tapering Edges of Hole

8. Working from the outside and using a file or grinder (Fig. 59), taper the edges of the hole at an angle of no more than 45 degrees.

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9. Remove flaky edges and feather the surface back about ½ inch beyond the damaged area by hand-sanding or power-sanding (Fig. 60) with 360-grit sandpaper.

10. Clean the area with a dry cloth or air.

IMPORTANT: Do not wipe with solvent.

11. Position the backing patch according to steps 10 through 16 on pages 16 through 18.

12. Fill the patch with body filler and finish the surface according to steps 17 through 24 on pages 18 and 19.

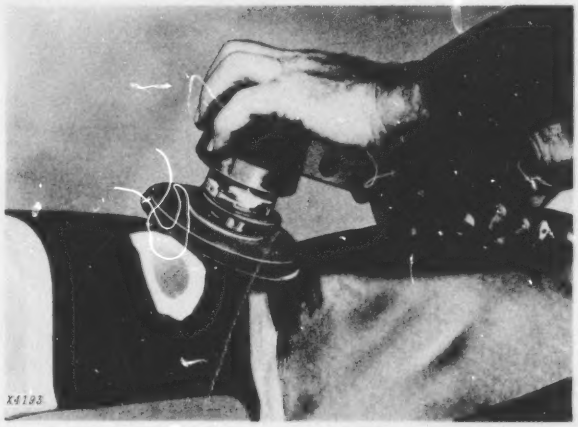

Fig. 60 — Removing Flaky Edges and Feathering Repair Area

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LARGE FRACTURES — SIMPLE CURVE

DEFINITION

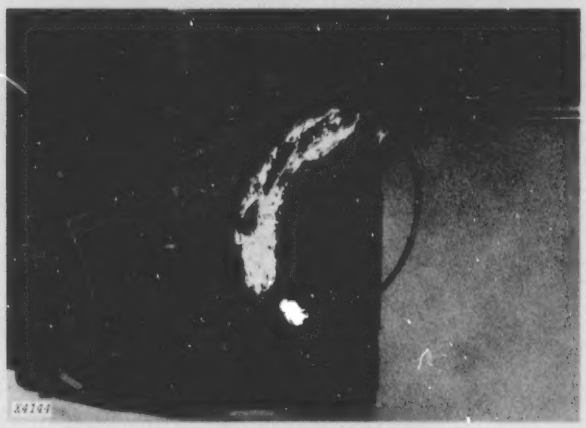

Fig. 61 — Example of a Large Fracture

Large fractures (Fig. 61) are punctures that are 3 inches or more in length.

REPAIR PROCEDURES

1. Gather the tools and materials listed on pages 5 through 8.

2. Repeat the preparatory steps given on page 9.

3. Repeat steps 3 through 9 on pages 15 and 16.

4. Prepare a backing patch according to steps 1 through 7 on pages 13 and 14.

5. Position the backing patch according to steps 10 through 16 on pages 16 through 18.

NOTE: If the adhesive is squeezed into the tapered hole during bonding, clean it out before the adhesive sets, and roughen any remaining adhesive with 360-grit sandpaper after it hardens.

6. While the adhesive is hardening, cut some pieces of mat (Fig. 62) to fit into the hole.

NOTE: The mat will serve as a filler, not as a structural reinforcement.

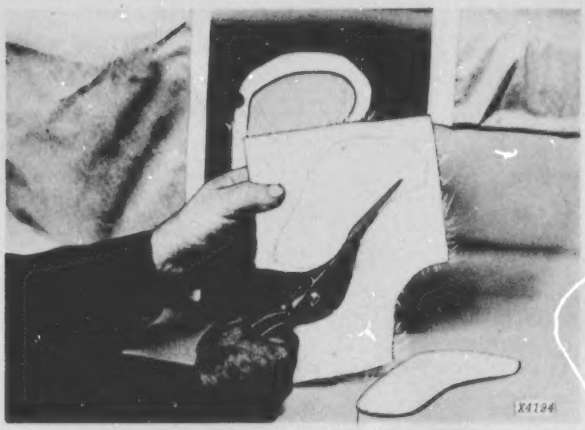

Fig. 62 — Cutting Mat to Fit the Hole

Fig. 63 — Applying Resin-Soaked Mat

7. Following the manufacturer's instructions, mix enough resin to saturate the pieces of mat.

8. Then lay up the resin-soaked mat by hand, one piece at a time (Fig. 63), until the top layer is just below the edge of the hole.

9. Allow the mat to harden. Then rough sand with 80-grit sandpaper.

10. Fill the patch with body filler and finish surface according to steps 17 through 24 on pages 18 and 19.

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FRACTURES — INACCESSIBLE UNDERSIDE

DEFINITION

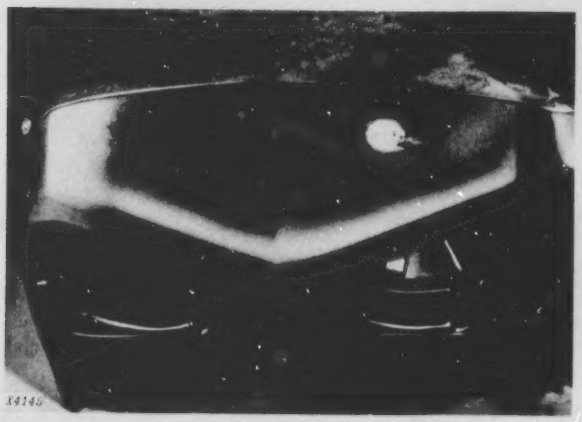

Fig. 64 — A Fracture Located in an Area Where the Underside is Inaccessible

Sometimes you will encounter large or small fractures on a surface that permits only limited access or no access to the underside (Fig. 64). The repair steps given here will show you how to install a backing patch under these conditions.

REPAIR PROCEDURES

1. Gather the tools and materials listed on pages 5 through 8, plus the following:

   24 inches of No. 20 wire

   Two 12 x ¾ x ¾-inch wood strips

   Wire cutters

2. Repeat the preparatory steps given on page 9.

3. Saw away the cracked and flaked material (Fig. 65) until you have a hole through which you can slip a backing patch.

CAUTION: Wear goggles and respirator when cutting, grinding or sanding.

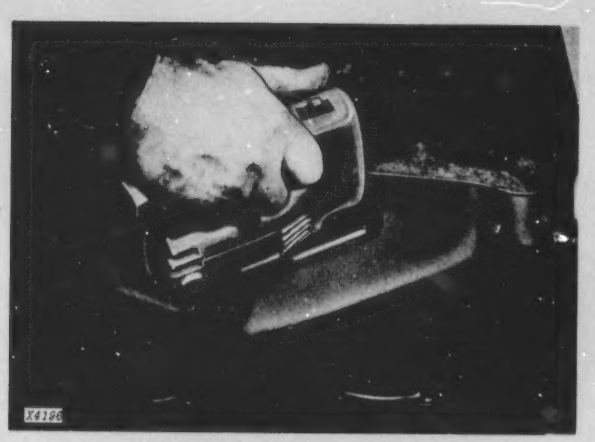

Fig. 65 — Sawing Away Cracked and Flaked Fiber Glass

4. Repeat steps 4 through 9 on pages 15 and 16.

5. Prepare a backing patch according to the procedures given on pages 13 and 14.

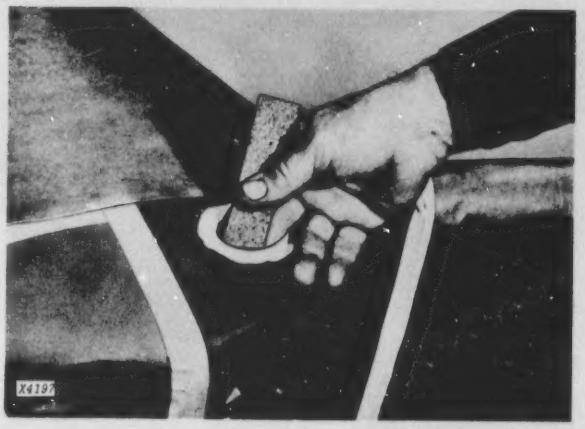

Fig. 66 — Sanding the Underside of the Repair Area

6. Working from the outside, reach through the hole and sand the underside of the repair area with 80-grit (or less) sandpaper (Fig. 66) to create a rough bonding surface approximately 2 inches from the edge of the repair area.

Fig. 67 — Roughening the Mating Surface of the Backing Patch

7. Sand the mating surface of the backing patch (Fig. 67) with 80-grit (or less) sandpaper, checking for a smooth fit to the underside. Clean all surfaces with air.

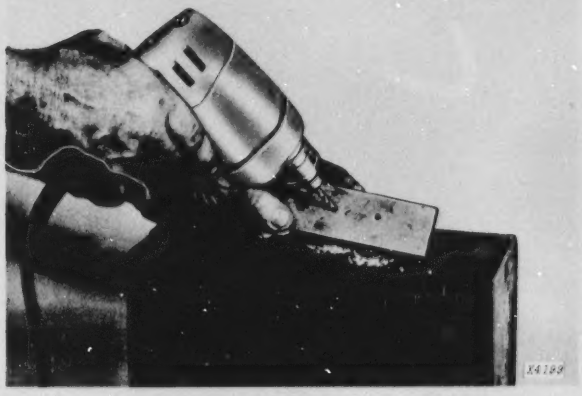

Fig. 68 — Drilling Holes in Backing Patch

8. To trial test the method of holding the backing patch in place, drill two holes (Fig. 68) in the patch at least ¾ inch apart (farther apart if possible).

9. Wax a piece of wire so it will be easy to remove after adhesive has been applied. Thread the ends of the wire through the two holes in the backing patch (Fig. 69). Then slip the patch into the hole and hold it in place by wrapping the wires around the wood strips.

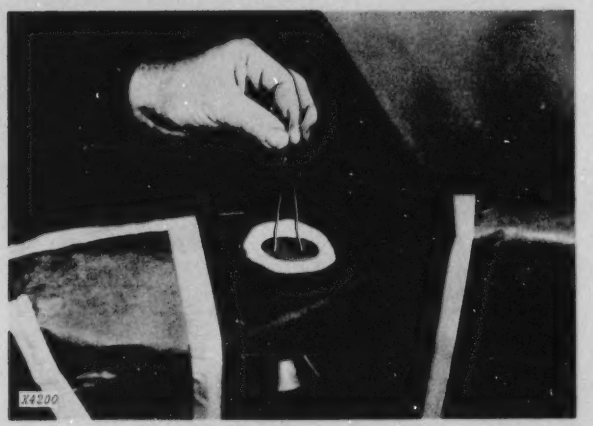

Fig. 69 — Wires Threaded Through Holes in Backing Patch

10. While the patch is in position, trace an outline of the damaged area. This outline will be used later as a guide when applying epoxy adhesive. Now remove the patch, trim it to required size and set it aside.

Fig. 70 — Mixing Epoxy Adhesive and Hardener

11. Mix epoxy adhesive (Fig. 70) according to the manufacturer's instructions.

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Fig. 71 — Applying Adhesive to Backing Patch

12. If possible, apply epoxy adhesive to underside of repair area, and to the patch (Fig. 71).

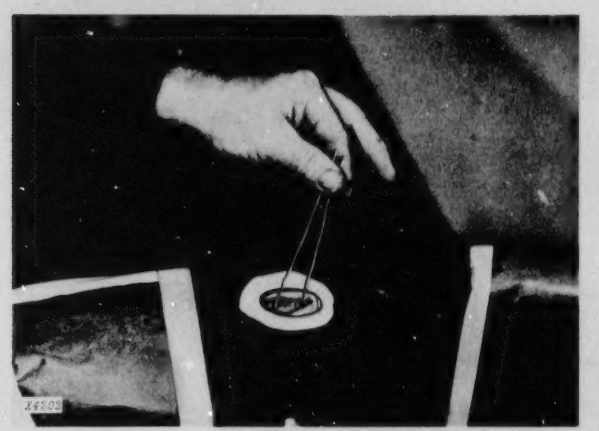

Fig. 72 — Fitting Backing Patch to Repair Area

13. Slip the patch into the hole, pulling hard on the wires (Fig. 72) until the adhesive squeezes out from all sides.

NOTE: If epoxy is squeezed into the tapered edges of the fracture during bonding, clean it out before the adhesive sets. Also roughen any remaining adhesive with 360-grit sandpaper after it hardens.

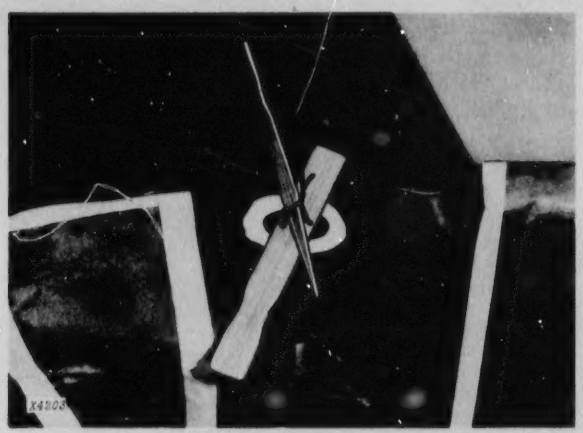

Fig. 73 — Backing Patch Held in Place by Wires and Wood Strips

14. Wrap the wires around the strips of wood (Fig. 73) to hold the backing patch in position until the adhesive sets.

15. When the backing patch is firmly in place, remove the wood strips. Remove the wires if possible; if not, clip them off as close to the surface of the patch as possible.

16. To complete the repair of a small fracture less than 3 inches in length, fill the patch following the instructions given on pages 20 and 21.

17. To complete the repair of a large fracture more than 3 inches in length, fill the patch following the instructions on page 22.

REPAIRING FRACTURES ON A COMPOUND CURVE

DEFINITION

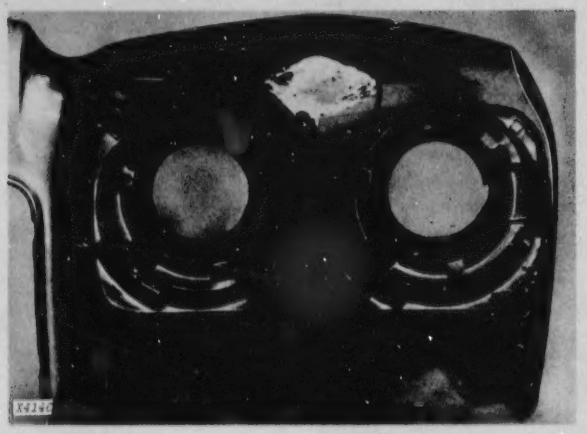

Fig. 74 — A Fracture on a Compound Curve

The term "compound curve" refers to surfaces having curvature in more than one direction (Fig. 74). Repairing such curves is rather difficult because a mold must be made to the contour to provide a base for the backing patch.

REPAIR PROCEDURES

1. Gather the tools and materials listed on pages 5 through 8, plus the following:

   Foamed plastic, clay, balsa or other material to form a mold

2. Repeat the preparatory steps given on page 9.

3. Saw away the cracked or flaked edges (Fig. 75), leaving a clean hole outlining the original damage. If panel is out of alignment, realign it with C-clamps or similar holding devices.

CAUTION: Wear goggles and respirator when cutting, grinding or sanding.

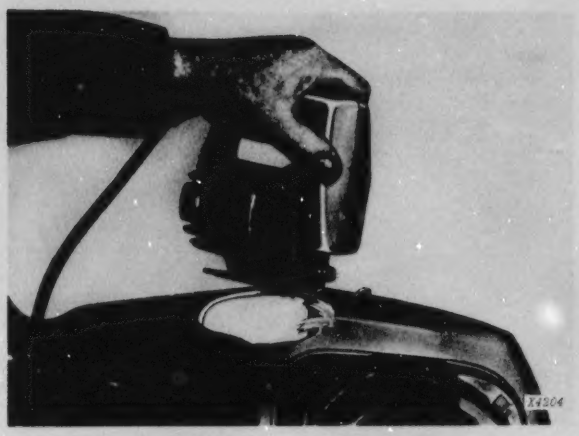

Fig. 75 — Removing Cracked and Flaked Edges

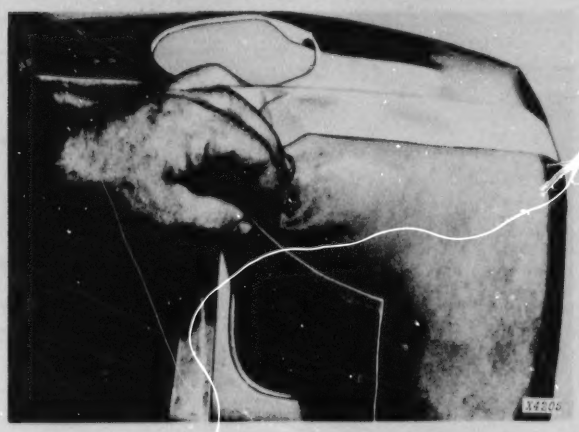

Fig. 76 — Masking Off Undamaged Surface

4. Mask off the undamaged surface (Fig. 76), leaving a working area of approximately 5 inches around the hole.

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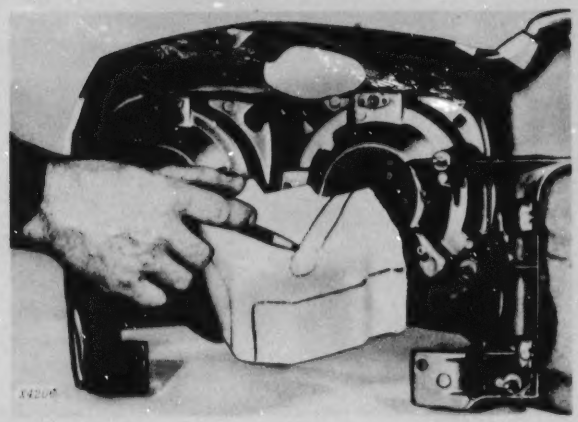

Fig. 77 — Forming a Mold of the Underside of the Damaged Area

5. Form a mold of the underside of the damaged area, using an easily shaped material such as foamed plastic, clay or balsa (Fig. 77).

IMPORTANT: When working with foamed plastic, keep it away from solvents and resins.

Fig. 78 — Covering Mold with Separating Film

6. Remove the mold and cover it with plastic separating film (Fig. 78).

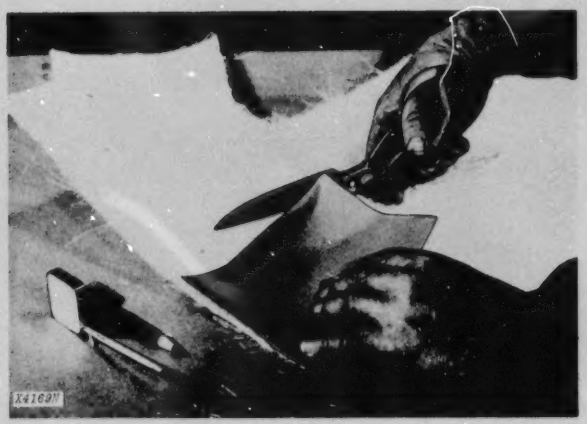

Fig. 79 — Cutting Fiber Glass Mat

7. Refer to the table on page 5 and then, using a cardboard template, cut the required pieces of fiber glass mat large enough to extend 2 inches beyond the edges of the repair area. See Fig. 79.

Fig. 80 — Mixing Resin and Hardener

8. Following the manufacturer's instructions, mix the recommended amount of resin (Fig. 80).

Fig. 81 — Applying Resin to Working Area of Mold

9. Apply some resin to the working area of the separating film on the mold (Fig. 81). Then place the first layer of mat on the separating film. Saturate the mat with resin using a stippling motion (that is, tap the work frequently with the bristle end of the brush).

Fig. 82 — Covering Mold with Resin-Soaked Mat

10. Lay up the remaining pieces of mat by hand (Fig. 82), one layer at a time, soaking each layer with resin as you apply it.

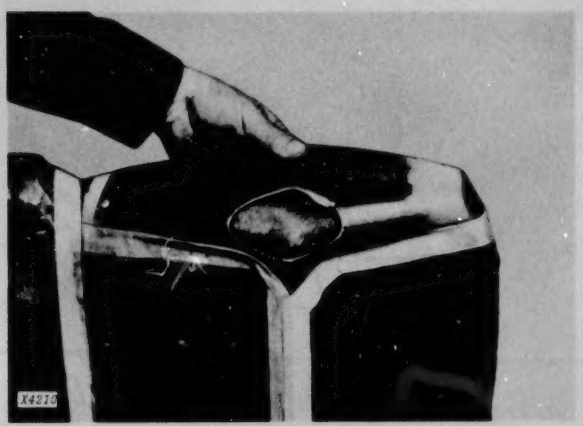

Fig. 83 — Fitting Hardened Patch to Damaged Area

11. Allow the resin-soaked mat to harden. Then pop it off, remove the separating film, and check the fit to the underside (Fig. 83).

12. If you are working on a small fracture, complete the repair according to the instructions on pages 20 and 21.

13. If you are working on a large fracture, complete the repair according to the instructions on page 22.

TEST YOURSELF

QUESTIONS

1. What is the "laminate"?

2. When tapering the edges of a crack or hole the maximum angle must be no more than:

   a. — 30°; b. — 45°; c — 60°

3. What is a backing patch?

4. A backing patch is used to repair:

   a. — Cosmetic damage; b — Structural damage

5. True or false? The ideal temperature and humidity for making repairs is 70°F. and 70 percent.

6. What is a compound curve?

7. In addition to regular materials, what is required to repair a fracture on a compound curve?

8. What is the usual thickness of most fiber glass/plastic parts?

   a. — 0.050″; b — 0.100″; c. — 0.125″

9. How many layers of 1½ oz. mat are required to repair most structural damage?

10. What is cellophane or similar material used for?

ANSWERS

1. The molded, hardened mixture of fiber glass and plastic; the finished product.

2. b. — 45°.

3. Laminate formed in the shape of the surface to be repaired and bonded with epoxy adhesive to the back side of the repair area.

4. b. — Structural damage.

5. True.

6. A surface having curvature in more than one direction.

7. A carved or otherwise fabricated mold shaped to the underside of the repair area.

8. b. — 0.100″.

9. Three.

10. As a separating film between a patch and the damaged area to which it is formed.

SUMMARY

This manual has explained briefly what fiber glass/plastic is, how and of what it is made, and how it is used.

You have been introduced to new terms, special repair materials, and specialized techniques.

Detailed instructions have been given for repairing the more common types of damage that may be encountered.

Since fiber glass/plastic is being used to make more and more products each year, knowing the procedures for repair is important to the serviceman and valuable to the layman.

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